

A new species of *Gnathia* (Isopoda: Cymothoida: Gnathiidae) from Ishigaki Island, the Ryukyus, southwestern Japan

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Abstract.— A new species of gnathiid isopod, *Gnathia camuripenis*, from coral rubble infauna collected in Ishigaki Island, the Ryukyus, southwestern Japan, is described. The gnathiid is the 20th species of the family Gnathiidae and 8th of the genus *Gnathia* recorded from Japan. Males of *G. camuripenis* have remarkably large penes fused into a single crooked blade and mandibles with 2 inner lobes, and thus are easily separated from its congeners. Female adults and larvae considered to be the same species are also described in detail and the morphology of antennae, mouthparts and pleotelson compared to other species from the same family.

Introduction

Gnathiids are most unusual isopod crustaceans, that show extreme morphological differences between juveniles (praniza stage) and adults and between adult males and females. Although the pranizae are adapted to ectoparasitism on fishes, adults are generally non-feeding and reproduce among benthic substrata, such as mud burrows, sponges, dead barnacles (Holdich & Harrison, 1980; Cohen & Poore, 1994). The temporary-parasitic pranizae detach from the host fish and take refuge in cryptic habitats. Pranizae have also been collected from these cryptic habitats, sometimes together with adults (Mouchet, 1928; Wägele, 1988; Klitgaard, 1991; Tanaka & Aoki, 1998).

Currently, over 160 species of Gnathiidae in 10 genera are reported worldwide, and 7 species in the genus *Caecognathia* Dollfus,

1901, 5 in *Elaphognathia* Monod, 1926 and 7 in *Gnathia* Leach, 1814 are known from the coastal water of Japan (Monod, 1926; Cohen & Poore, 1994; Saito *et al.*, 2000). However, no taxonomically definite records have been available from the Ryukyus, southwestern Japan.

In the course of an ecological survey of coral rubble infauna, conducted by Dr. Y. Takada of the Seikai National Fisheries Research Institute, Fisheries Research Agency, gnathiids, including adult males, females and pranizae belonging to a single new species, were collected in Urasoko Bay, Ishigaki Island, first record of Gnathiidae from the Ryukyus, Japan. The male specimens, although belonging to *Gnathia*, had distinctive morphological features never found in previously described species in this genus.

Materials and Methods

Gnathiid isopods were collected by Dr. Y. Takada using a coral rubble trap in Urasoko Bay, Ishigaki Island, the Ryukyus, Japan during 1997–2003. The traps consisted of plastic baskets (26 × 21 × 7 cm) filled with coral rubble that were placed in 0.5–1 m depth for several weeks and then retrieved.

Specimens were fixed and preserved in 70 % ethanol. They were classified into adult males, adult females and larvae and were dissected using fine needles under a binocular microscope. Each appendage separated from the body was mounted in Canada balsam on a glass slide. Observations were made with a light microscope equipped with a Nomarski differential interference contrast device, and drawings were made with the

aid of a camera lucida.

The identification of gnathiid isopods is based solely on the morphology of adult males, and descriptions of larvae and females of many species are insufficient or lacking. This problem has made the identification of female and larval gnathiids difficult. However, in this study, different stages were sometimes found together in the same sample and therefore considered to belong to same species.

Measurements given in this paper indicate the length from the tip of the head to the posterior end of the pleotelson. Specimens examined are deposited in the National Science Museum, Tokyo (NSMT) and the Natural History Museum and Institute, Chiba (CBM-ZC).

Taxonomy

Gnathia camuripenis, new species

Figs. 1–4

Material examined.—Holotype: ♂, 2.5 mm, 7 May, 1998, NSMT Cr 15701. Paratypes: 4 ♂, 2.3 mm (NSMT Cr 15702), 21 Oct. 1997, 2.8 mm (CBM-ZC 7888), 2.1 mm (CBM-ZC 7889) and 2.5 mm (CBM-ZC 7892), 5 Nov. 2003; 4 ♀, 2.3 mm (NSMT Cr 15703), 21 Oct. 1997, 2.4 mm (NSMT Cr 15704), 7 May, 1998, 3.1 mm (CBM-ZC 7890) and 2.3 mm (CBM-ZC 7893), 5 Nov. 2003; 5 pranizae (juveniles), 2.7 mm (NSMT Cr 15705), 7 May, 1998, 1.9 mm (NSMT Cr 15706) and 2.8 mm (NSMT Cr 15707), 13 Jan. 1998, 2.6 mm (CBM-ZC 7891) and 3.0 mm (CBM-ZC 7894), 5 Nov. 2003. Urasoko Bay, Ishigaki Island, the Ryukyus, Japan (124° 13' E, 24° 27' N), 0.5–1 m depth, trap with coral rubble, coll. Y. Takada.

Description of male holotype (Figs. 1–2).—Cephalosome rectangular with lateral margins slightly convex, one-fourth length of animal. Eyes well-developed, lateral and sessile, each composed of about 50 ommatidia. Supra-ocular lobe present. Frontal border transverse. Mediofrontal process inferior, conical with a few setae laterally.

Superior frontolateral process conical, bearing 1–2 setae on outer margin; external scissura rounded. Dorsal sulcus deep and narrow. Paraocular ridge partially obscuring eye. Long translucent elliptical region presents anteromedially, above buccal cavity.

Pereonites smooth, with several simple setae of various sizes. Pereonite 1 very short, reaching lateral margins of cephalosome. Pereonite 2 concave, along posterior margin of cephalosome. Pereonite 3 slightly longer than 2. Pereonite 4 with a slight anterior constriction. Pereonites 5 and 6 as long as rest combined. Pereonite 7 short, narrow, overlapping pleon.

Pleon straight with pleonites subequal in length; pleonal epimera not pronounced in dorsal view. Pleonites 1–4 subequal in width, 5 narrower; short simple setae on lateral and posterior margins of pleonites. Pleotelson triangular, basal width greater than length; lateral margins sinuous, excavate distolaterally, with 3 pairs of simple setae on dorsal and 1 pair of setae on distal apex.

Antenna 1 (Fig. 1C) with peduncular articles 1 and 2 subequal and together subequal to 3. Peduncle 1 with 1 seta and 1 feather-like bristle; peduncle 2 bearing 2 feather-like bristles and 4 simple setae distally. Peduncle 3 longest with 4 simple setae. Flagellum of antenna 1 with 5 articles; article 1 and 5 reduced; 3 aesthetascs on distal 3 articles. Antenna 2 (Fig. 1D) with 4 peduncular and 7 flagellar articles, 1.5 times as long as antenna 1. Peduncular articles 1 and 2 short and together subequal to length of article 3. Article 3 bearing 1 feather-like bristle and 11 simple setae. Article 4 slightly longer than 3, as long as flagellum, with numerous simple setae.

Mandibles (Fig. 1E) raised anteriorly, subequal to length of cephalosome, with acute apex curved inward and slight mandibular incisor half-way along. Carina unarmed. Ventral crenulate blade on distal two-thirds. Two lobes on proximal one-third; superior lobe obscuring distal inferior lobe. Basal neck short.

Maxilliped (Fig. 1F) with basis and four-

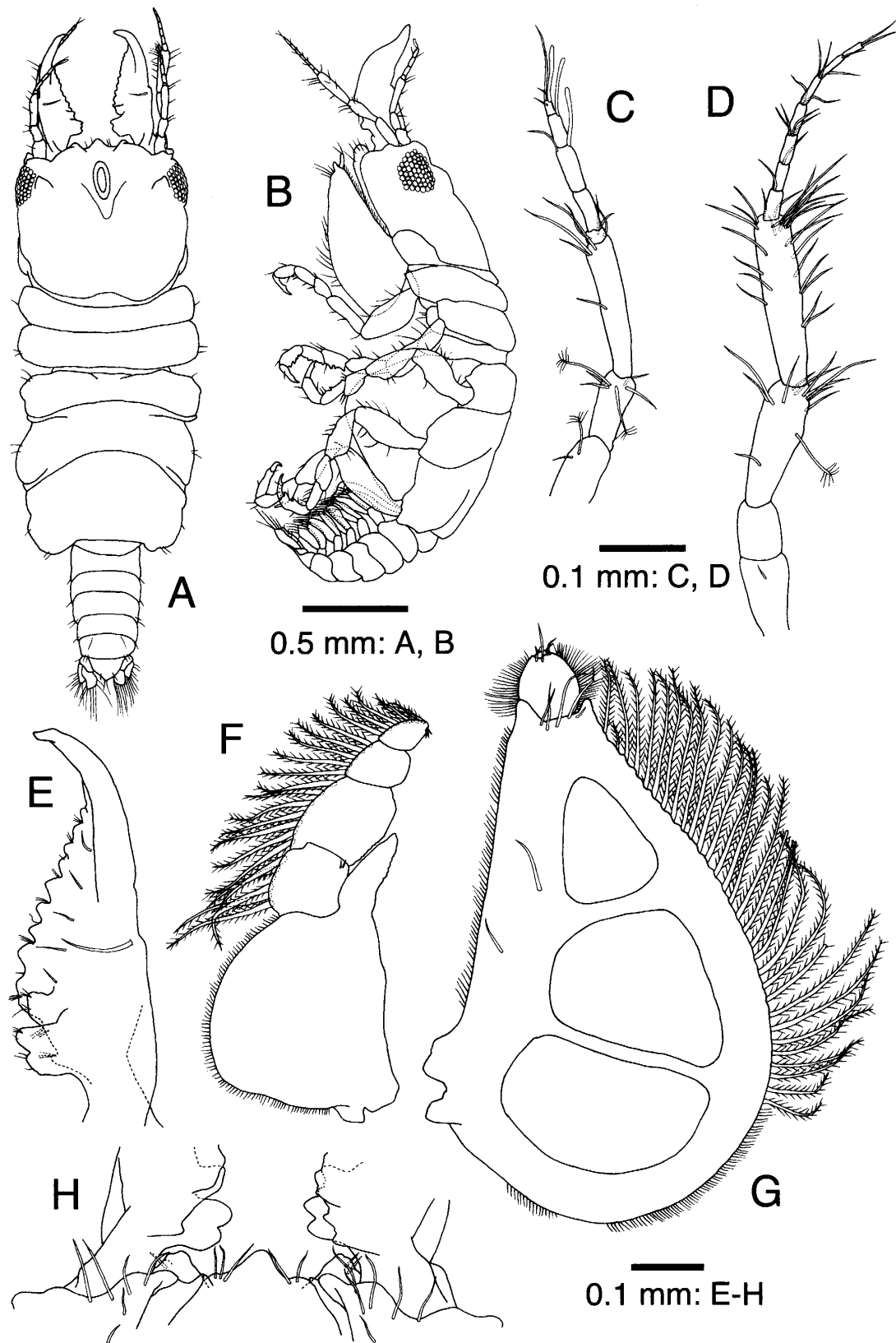


Fig. 1. *Gnathia camuripenis*, new species: holotype, male (2.5 mm, NSMT Cr 15701). A, dorsal view; B, lateral view; C, antenna 1; D, antenna 2; E, mandible; F, maxilliped; G, pylopod; H, ventral view of frontal margin of cephalon.

articled palp. Endite reaching middle of article 2 of palp. External margins of palp bearing plumose setae. Palp article 1 with 2 short simple setae distally on lower surface; 3 short setae on tip of palp.

Pylopod (Fig. 1G) 3-articled. Article 1 large, with 30 plumose setae on internal margin, 5 simple setae distally on ventral surface and 2 setae along external margin; 3 areolae visible. Article 2 bearing 4 simple setae distally on lower surface. Article 3 small, with 2 simple setae.

Pereopods (Fig. 2A–E) of usual gnathiid form; simple setae fringe oblong basis; ischium with numerous simple setae, rectangular and shorter than basis. Merus half the length of ischium, with 1–3 simple setae in pereopods 2–5 and 1 simple seta and 2 serrated spines in pereopod 6 on distal bulbous protrusions; inner margins bearing tooth-like tubercles. Carpus of almost same size and shape as merus, but without distal protrusion; 1 short serrated spine on distal end in pereopods 2 and 6. Propodus oblong, longer than carpus, with dentate margin bearing simple setae; 2 spines on inner mid and distal point of propodus. Dactylus half the length of propodus, terminates in sharp pointing unguis, with a few simple setae. Pereopods 2 and 3 directed anteriorly and pereopods 4–6 posteriorly. Numerous pectinate scales on propodus and carpus of pereopods 2, 3 and 6.

Penes (Fig. 2H) fused, prominent, half length of pleon; bent posteriorly on distal one-fourth.

Pleopods having both rami. Basis bearing 1 short simple seta and 2 coupling hooks on outer and inner margins, respectively. Exopod smaller than endopod; both rami with fringe of plumose setae. Endopod of pleopod 2 lacking appendix masculina (Fig. 2G).

Uropodal peduncle with 2 simple setae on dorsal and 1 seta on ventral. Uropodal rami subequal in length, bearing numerous simple setae on outer and plumose setae on inner margins; endopod extending beyond apex of pleotelson (Fig. 2F).

Description of female (Fig. 3).—Cephalosome rectangular, 1.5 times as wide as long. Frontal margin broadened, roundly produced; posterior margin slightly convex. Eyes well developed, lateral and sessile. No sulcus and paraocular ornamentation.

Pereon swollen with sutures between pereonites 4–7. Pereonites 1–3 very short. Pereonite 1 slightly narrower than cephalon, enclosed by cephalon and pereonite 2. Pereonite 3 wider than pereonite 2, reaching lateral margins of anterior segment; posterior margin concave. Pereonites 4–6 dilated, thin, not well chitinized, two thirds width of length combined. Pereonite 7 dorsally visible, short, narrow, with rounded posterior margin.

Pleon and pleotelson less than a quarter of total length, similar to those of male but lateral margins of pleotelson crenulated on distal one third.

Antenna 1 (Fig. 3B) with 3 peduncular and 4 flagellar articles. Peduncular article 1 with 1 seta; article 2 with 3 feather-like bristles. Article 3 with 5 simple setae and 1 feather-like bristle. Flagellar article 2 and 3 with 1 aesthetasc each; article 4 terminating in 1 aesthetasc and 4 simple setae. Antenna 2 (Fig. 3C) longer than antenna 1, with 4 peduncular articles and 7 flagellar articles. Peduncular articles 1 and 2 short, together subequal to length of article 3. Article 4 largest, with 8 simple and 3 feather-like setae. Flagellum terminating in 5 setae on article 7.

Maxilliped (Fig. 3D) consists of coxa with attached oostegite, basis and 4-articled palp. Endite setose, reaching article 2 of palp; 4 plumose setae on basis. Palp fringed with plumose setae on external margin, with 2 short simple setae distally.

Pylopod (Fig. 3E) 4-articled. Article 1 widest, curved anteriorly. Article 2 fused with article 1, with 1 simple seta distally. Article 3 narrow, subequal to length of article 2, bearing 6 setae distally. Article 4 very small, overlapped by setae of article 3, with 2 short simple setae. Pylopodal oostegite narrow, notched anteriorly, longer than pylo-

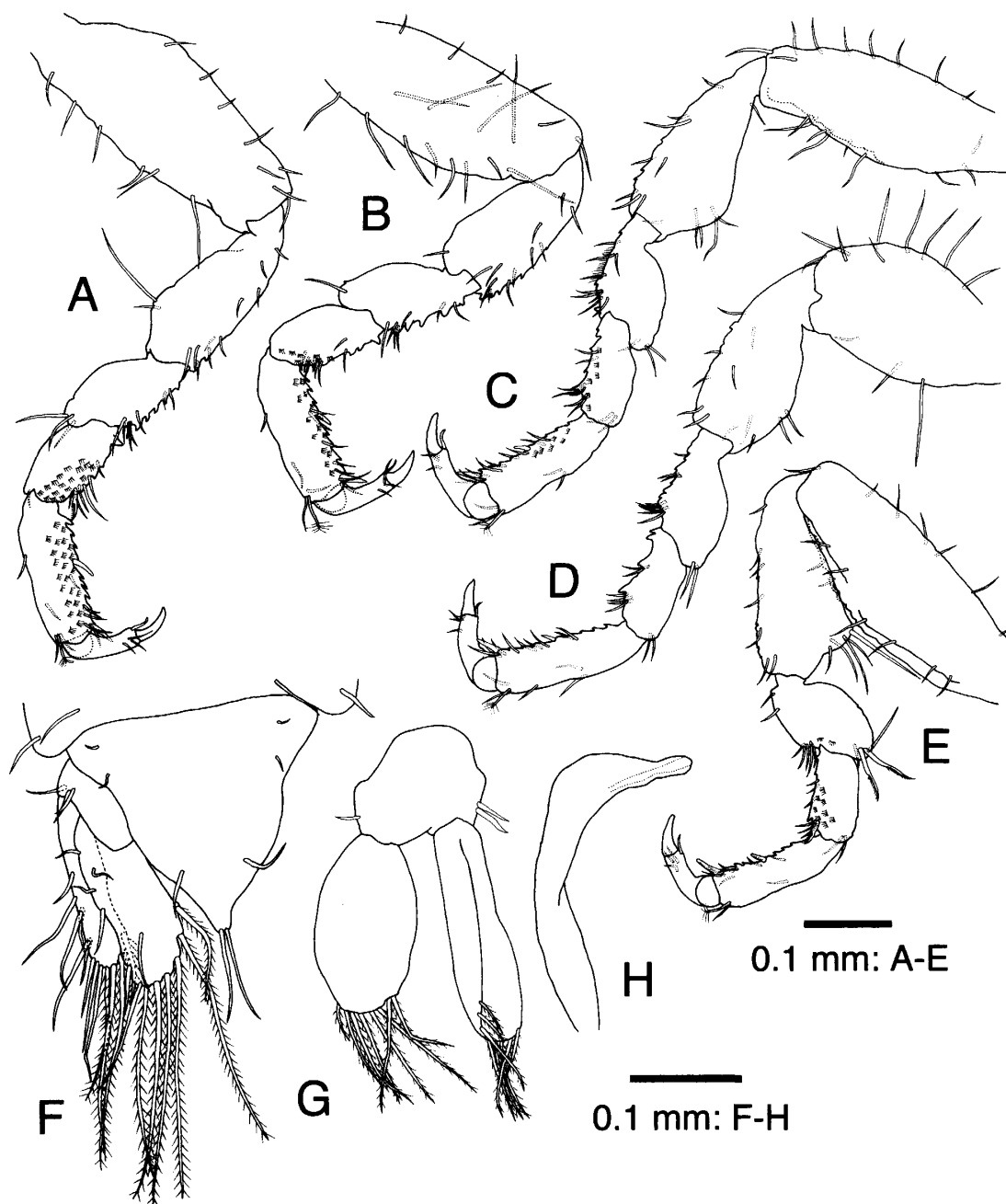


Fig. 2. *Gnathia camuripenis* sp. nov. Holotype male (2.5 mm, NSMT Cr 15701). A-E, pereopod 2-6; F, pleotelson; G, pleopod 2; H, penis (lateral view).

pod.

Pereopods (Fig. 3F-J) similar to those of male but less robust and less setose. Basis slender, with a few seta in pereopod 2 and 3; 3 feather-like bristles in pereopods 4-6. Distal bulbous protrusion of merus weaker than that of male.

Pleopods subequal, similar in basic morphology and setation to those of male (Fig.

3K).

Uropodal endopod (Fig. 3L) with 3 feather-like bristles on ventral surface, bearing 6 plumose setae on inner margin and 3 simple setae on outer margin. Exopod with 3 plumose setae and 7 simple setae on inner and outer margin, respectively.

Description of praniza (Fig. 4).—

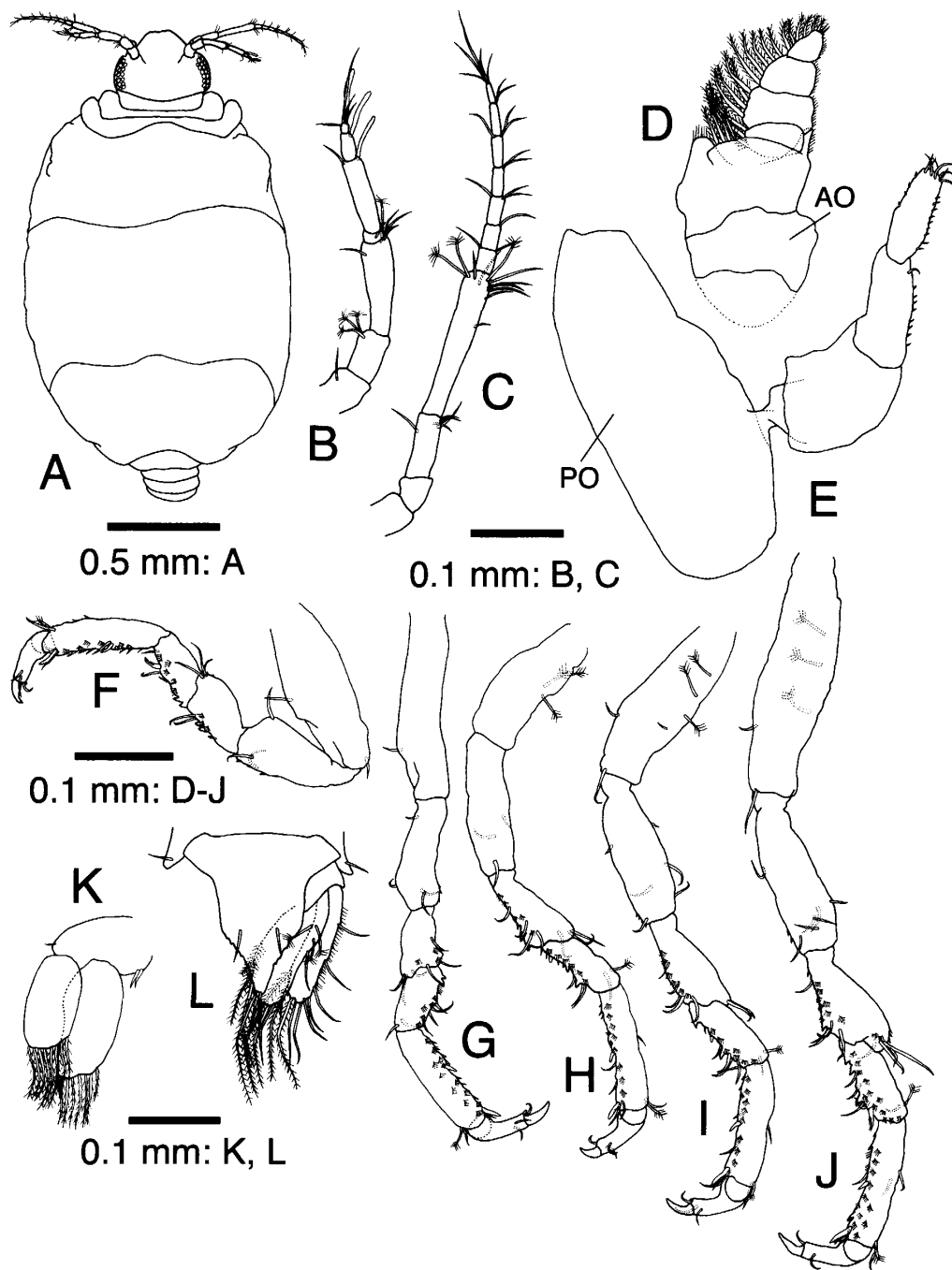


Fig. 3. *Gnathia camuripenis*, new species: paratype, female (2.3 mm, NSMT Cr 15703). A, dorsal view; B, antenna 1; C, antenna 2; D, maxilliped; E, pylopod; F-J, pereopod 2-6; K, pleopod 2; L, pleotelson; AO, attached oostegite of maxilliped; PO, pylopodal oostegite.

Cephalosome rectangular, wider than length; posterior margin slightly concave, wider than anterior margin. Eyes well developed, bulbous, lateral and sessile, with many small ommatidia. Labrum prominent, one fourth length of cephalosome. Ventral part of labrum gutter-like with central groove,

covers mandibles dorsally and laterally. No sulci or tubercles on dorsal cephalon.

Pereonite 1 very short, fused with cephalon. Pereonite 2 with anterior constriction separating it from pereonite 1. Pereonite 3 slightly longer and wider than pereonite 2. Pereonites 4-6 partly swollen, with sutures

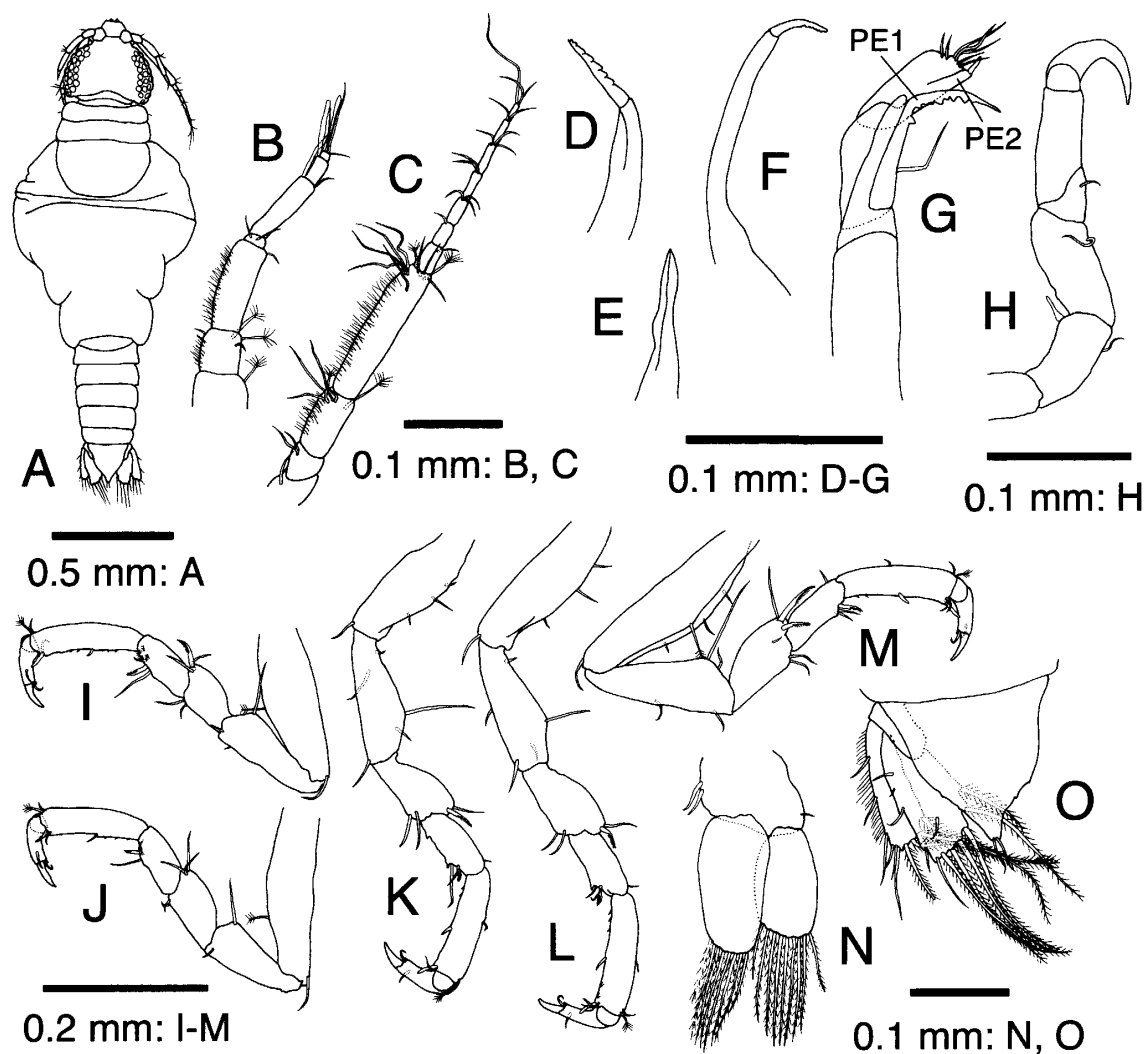


Fig. 4. *Gnathia camuripenis*, new species: paratype, praniza (1.9 mm, NSMT Cr 15706). A, dorsal view; B, antenna 1; C, antenna 2; D, mandible; E, paragnath; F, maxillule; G, maxilliped; H, gnathopod; I-M, pereopod 2-6; N, pleopod 2; O, pleotelson. PE1, palp endite 1 of maxilliped; PE2, palp endite 2 of maxilliped.

on dorsal surface; large posteriorly rounded tergite visible on pereonite 4. Pereonite 7 very small, overlapping pleon.

Pleon straight with pleonites subequal in length; epimera not visible. Pleonites 1-4 subequal in width, 5 narrower. Pleotelson subtriangular, with 2 simple setae on notched apex; lateral margins sinuous, bearing 2 small teeth each.

Antenna 1 (Fig. 4B) with 4 peduncular articles; article 1 short with 1 feather-like bristle; article 2 narrower than 1, setose, bearing 2 feather-like bristles and 1 short simple seta. Peduncular article 3 setose,

subequal length to article 1 and 2 combined. Flagellum with 4 articles, article 2 largest; articles 2 and 3 with 1 aesthetasc each; article 4 terminating in 1 aesthetasc and 2 simple setae. Antenna 2 (Fig. 4C) with 4 peduncular and 7 flagellar articles, 1.5 times as long as antenna 1. Peduncular articles 1 and 2 short, together subequal to 3. Peduncular articles 3 and 4 setose; article 3 bearing 2 feather-like bristles and 3 simple setae; article 4 long, with 2 feather-like bristles and 8 simple setae distally. Flagellum as long as peduncles 3 and 4 combined, terminating in 3 simple setae.

Mandible (Fig. 4D) stout, with sutures on distal one-fourth, terminating in stylus with 2 small and 5 large teeth on mesial margin.

Maxilla reduced.

Maxillule (Fig. 4F) elongated, slender, curved ventrally, with 6 small teeth on distal apex.

Paragnath (Fig. 4E) stout, tapering to sharp point, without teeth.

Maxilliped (Fig. 4G) well-developed, of basis and 2 palp articles, all with endites. Endite of basis elongated, with round apex. Palp broad, curved ventrally, with 7 simple setae distally. Palp endite 1 terminates in acute apex, with 1 long simple seta and 9 teeth on ventral margin. Palp endite 2 lies along upper margin of article; apex rounded, bearing 1 blunt spine and 1 simple seta.

Gnathopod (Fig. 4H) pediform, smaller than pereopods. Basis short; 1 simple seta and 1 spine on ischium; merus as long as ischium, with 1 seta; carpus reduced, subtriangular, bearing 1 short simple seta; propodus oblong; dactylus forming sharp pointing unguis.

Pereopods (Fig. 4I–M) slender, with few pectinate scales; pereopods 2 and 3 directed anteriorly and pereopods 4–6 posteriorly. Pereopod 2 basis oblong, with 1 feather-like bristle and 1 simple seta. Ischium rectangular, two-thirds length of basis. Merus short, with distal bulbous protrusion bearing 2 simple setae and 1 serrated spine. Carpus subequal length to merus, 2 simple setae and 1 serrated spine on inner margin. Propodus as long as merus and carpus combined. Dactylus half the length of propodus, terminates in sharp pointing unguis. Pereopods 3–6 similar to pereopod 2, but pereopod 3 lacking serrated spine on merus; basis of pereopods 4–6 more setose than pereopod 2; merus of pereopod 6 bearing 2 serrated spines.

Pleopods subequal. Basis bearing 1 short simple seta on outer margin and 2 coupling hooks on inner margin. Exopod smaller than endopod; distal ends of both rami fringed with plumose setae (Fig. 4N).

Uropodal rami (Fig. 4O) subequal in length; endopod beyond apex of pleotelson. Endopod with 3 short simple setae dorsally; 3 simple and 8 plumose setae on outer and inner margin, respectively. Exopod narrower than endopod, with 6 simple setae on outer margin; 4 plumose setae on inner margin.

Remarks.— For the identification of male gnathiids to genus, the morphology of mouthparts and shape of cephalon are important (Monod, 1926; Cohen & Poore, 1994). The following features displayed by the present new species indicate that it belongs to *Gnathia*, the largest genus, containing over 70 species, 7 of which have been reported from the coastal water of Japan: maxillipeds of 5 articles; large distinctive pylopods of 3 articles; processes of the frontal border of the cephalon; mandibles with ventral crenulate blade.

The large penial blade of *Gnathia camuripenis* links the new species to *G. falcipenis* Holdich & Harrison, 1980 and *G. epopostruma* Cohen & Poore, 1994, both from Australian waters. In *G. falcipenis*, penes are fused into a laterally compressed blade. It is scythe-shaped and curved anteriorly (Holdich & Harrison, 1980). However, in *G. camuripenis*, the blade is bent posteriorly, thus, easily distinguished from that of *G. falcipenis*. Although the penes of *G. epopostruma* are prominent, they form 2 large papillae, never fused into 1 (Cohen & Poore, 1994). *Gnathia phallonajopsis* Monod, 1926 from the Mediterranean Sea also show a remarkable projection of fused penes (Monod, 1926), but the projection with 2 lateral expansion is compressed dorsoventrally and different from that of *G. camuripenis*.

Except for the penial projection, *Gnathia camuripenis* shares basic features with other species of *Gnathia*. However, the new species is distinguished from others by the combination of following points; mandibles with dentate blade and 2 internal lobes; three processes (one mediofrontal and a pair of superior lateral) of the frontal margin of the cephalon; absence of paraocular ornamentation.

A translucent elliptical region, located above the buccal cavity, was observed in *Gnathia camuripenis*. Although the function and evolutionary importance are unclear, this structure, in various shapes and sizes, is also known in some other species of Gnathiidae (Cohen & Poore, 1994). Among Japanese species, the original description of *G. hirayamai* Nunomura, 1992 (Nunomura, 1992) indicates a similar region. However, that of *G. camuripenis* is longer and larger than that of *G. hirayamai*.

Although most authors have ignored or only very briefly described females in the species descriptions of gnathiids, Smit *et al.* (2002) redescribed females of *Gnathia africana* Barnard, 1914 from southern Africa in detail. The gnathiid was compared with species in other genera, *Paragnathia formica* (Hesse, 1864), *Euneognathia gigas* (Beddard, 1886) and *Caecognathia calva*, (Vanhöffen, 1914) and separated from those by the number of flagellar articles of antenna 2, number of pylopodal articles, morphology of frontal border of cephalon and shape of pleotelson. In the present study, *Gnathia camuripenis* females showed cephalon with a rounded frontal border, antenna 2 of 7 articles, pylopod of 4 articles and pleotelson as broad as long, which corresponded to those of *G. africana*. However, *G. camuripenis* differs from *G. africana* in the following features: short broadened cephalon; concave posterior margin of pereonite 3; maxillipedal endite reaching article 2 of palp; more setae on pylopodal article 3. In Japan, Nunomura (1998) reported a female considered to be *Gnathia sanrikuensis* Nunomura, 1998 from northern Japan, but the mouthparts were not described. The frontal margin of the female gnathiid is not rounded but notched, and eyes are smaller than in *G. camuripenis*. The difference in the number of setae of uropodal exopod was also found between females of the two species.

Identification of larval gnathiids might be more difficult than of females, since they are similar in basic morphology even between genera. However, larvae of *Gnathia*

camuripenis are separated from *G. africana*, redescribed by Smit (1999), by the smooth ventral margin of gnathopod, elongated basal endite of maxilliped, fewer number of mandibular teeth and more teeth of palp endite 1 of maxilliped (9–10 and 5–7 teeth in *G. africana*, respectively). Although a juvenile gnathiid considered to be *Elaphognathia sugashimaensis* (Nunomura, 1981) from central Japan has 7 teeth on the mandible, the gnathiid showed 5 flagellar articles in antenna 2 and long pleotelson (Nunomura, 1981), and is thus easily distinguished from *G. camuripenis*. Larvae of *G. camuripenis* are also different from the praniza larva considered to be *Gnathia sanrikuensis* by less robust antenna 1 and thinner stylet of mandibles.

Etymology.— The specific name, *camuripenis*, is derived from the Latin meaning crooked penis, which is the distinctive feature of the new species (noun in apposition).

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